Fin Whale in the Liguro-Provencal Mediterranean Sea: population state, distribution and habitat use

N. Di-Méglio [1], L. David [1], H. Budzinski [2], L. Peluhet [2], N. Tapie [2], D. Ody [3], A. Eynaudi [3], A-M Risterucci [4] and T. Legavre [4]

(1) EcoOcéan Institut, 18 rue des Hospices, 34090 Montpellier - France / ecoocean@wanadoo.fr
(2) Université bordeaux 1, ISM/LPTC UMR 5255 CNRS - France
(3) WWF, 6 rue des Fabres, 13001 Marseille- France
(4) CIRAD, UMR DAP 1096 ; INRA, Sup-Agro, Université Montpellier 2, CIRAD - France

Introduction

Because some elements of the fin whale (*Balaenoptera physalus*) ecology in the Mediterranean Sea remain still ignored, WWF-France, the Nicolas Hulot Foundation and the Paul Ricard Oceanographic Institute launched "Objectif/Cap Cétacés": a multi-field program on this species. The aim of this programme consisted in characterization the health of the population and the behavioural ecology of the animal in the liguro-Provencal Mediterranean Sea.

Material and methods

- Several missions at sea from May to October in 2006, 2007 and 2008 totalized 6590 km in effort (line transect method, Buckland *et al.* 1993) and 178 sightings of finwhales. Out of transect we made 670 hours of watch, succeed in 38 biopsies and record times of surfacing and diving of 52 individuals. Samples of three stranding animals have also been analyzed.
- For sex determination the genes ZF-X and ZF-Y were amplified as described by Bérubé and Palsbøll (1996), and for genetic identification (NJ and "Parenté"), 11 microsatellite markers were highlited based on Bérubé *et al*., 1999 and Palsbøll *et al*., 1997.
- Analyses of Neighbor-Joining (NJ) were carried out with the Darwin software (http://darwin.cirad.fr/darwin/Home.php) and the kinship relations with the "Parenté" software (http://www-leca.ujf-grenoble.fr/logiciels.htm)
- The Persistent Organic Pollutants (PCBs, PBDEs and OCP) were extracted following the protocol developed by Tapie *et al.,* 2008. The value measured in fresh weight are corrected by the lipid content of each sample and are expressed in ng.g^{-1} lw.
- The samples present capture/recapture of some individuals during the same year or between two years and as well as a mother and her progeny. Those data made it possible to gauge and validate each step of the genetic or contaminant analysis.

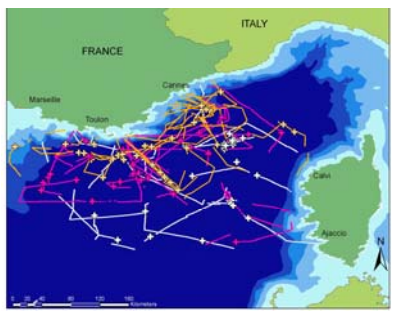

Fig.1 : effort and sightings of finwhales in 2006 (white), 2007 (pink) and 2008 (orange)

Results

The analyzed fin whales show similar levels of PCBs and OCPs (around 6000 ng.g-1 lw). The levels of PBDEs are definitely lower (around 100 ng.g-1 lw).

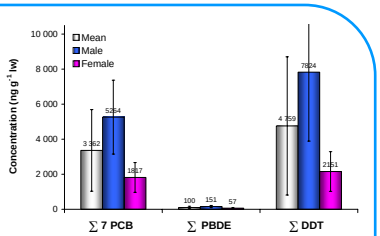

Fig.2 : contamination level of Fin whale

The difference in contamination between the sexes is very marked : the males are significantly 2 fold higher contaminated than the females for all the analyzed contaminants. Fin Whales present a low contamination for PBDEs and a residual medium contamination for PCBs and OCPs.

The NJ method builds a tree by connecting the closest operational taxonomic units by nodes which represent a common ancestor, based on the integration of the allelic data of 11 microsats of the individuals of 2006 (A), 2007 (B), 2008 (C) and of the 3 stranded animals (EM).

The tree (Fig.3) shows a clear structure in three groups, whatever the year of the biopsy. There is a homogeneous distribution of the males (blue) and females (pink) between the groups.

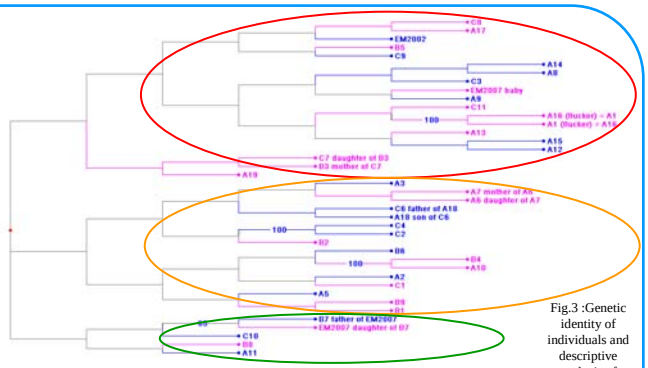

Fig.3 :Genetic identity of individuals and descriptive analysis of genetic diversity

The calculation of kinship relations, which integrates the allelic frequencies and their force, gives a probability of relation "mother/daughter" of 89% for A7/A6 and B3/C7. Two other relations are also highlighted: EM2007 and A18 could be respectively the progeny of the male B7 and C6 with a probability of 56%.

Table 1 : mean group size, relative abundances in and out conditions of line transect for three years

	2006	2007	2008
Mean group size (SD)	2,8 (2,1)	1,6 (0,7)	1,2 (0,5)
Nb of individuals **in Transect** + **out of Transect** = total	35+57 = 92	42+2 = 44	38+4 = 42
Nb of Km (**in Transect**)	2023	2158	2409
Relative abundance (nb individuals/**km in Transect**)	**0,017**	**0,019**	**0,016**
Relative abundance (nb individuals/ **hour of watch out of Transect**)	**0,82**	**0,02**	**0,07**

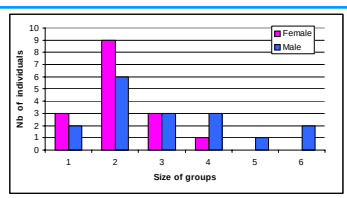

Fig.4 : repartition of sex determined individuals in their group size of sighting (2006 to 2008)

2006 : the fin whales were in bigger groups (tab.1), with many social interactions as pursuit, rolling, chasing, breaching (fig.5). The sex ratio is nearly in balance (tab. 2).
2007 : the fin whales were less numerous, dispersed in small groups (tab.1), never seen in interactions, more often searching for food actively or stationary (fig.5), performing longer dives and very discrete in surfacing (tab.3).
2008 : fin whales were less numerous, most of the time alone (tab.1), mainly traveling (Fig.5), and the sex ratio is in balance (tab.2).

Table 2 : sex ratio for three years

	2006	**2007**	**2008**
N	*18*	*9*	*9*
Female	41 %	78 %	44 %
Male	59 %	22 %	56 %

Table 3 : mean diving and surfacing time

	2006	**2007**
N for diving time	*368*	*258*
Mean diving time (SD)	**3'35** (2'10)	**8'35 *** (5'37)
N for surfacing time	*387*	*272*
Mean surfacing time (SD)	**1'45** (1'18)	**2'40** (2'53)

*: P > 0,0001 => **Différence entre 2006 et 2007 extrêment significative** Test de Mann-Whitney

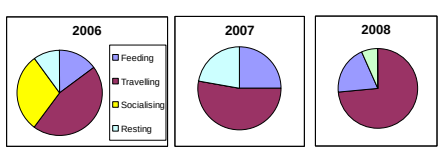

Fig.5 Ratio of behaviours (%)

Discussion-Conclusion

The contamination of fin whales shows a reduction in terms of levels in comparison to results published ten years earlier (Marsili et Focardi, 1996; Gauthier *et al.* 1997 a, b), whereas these animals are weakly impacted by PBDEs. These results are the reflect of the evolution of these contaminants in the ecosystem, in particular for PCBs banned since more than 30 years in France.

The results of sex ratio, behaviour, size of group and distribution vary according to the years, which is probably the reflection of the availability of the trophic resource. 2006 appears rich in biomass in spring, as 2008. On the other hand 2007 seems relatively poor in biomass (fig.6). This could explain that in 2006 animals could take time to socialise if there are not hungry, whereas in 2007 they could not if they search for food.

The results of behaviours, sex ratio, repartition of male and female in different group size (fig.4), and four observations of "a female leader followed by a male flanker" could highlighted the potential use of the zone also for the reproduction.

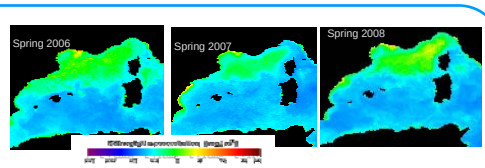

Fig.6 : Distribution and values of chlorophyll-*a* (Merged chlorophyll from *Aqua-MODIS and SeaWiFS*) in spring 2006, 2007 and 2008 (http://oceancolor.gsfc.nasa.gov/cgi/level3.pl)

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